



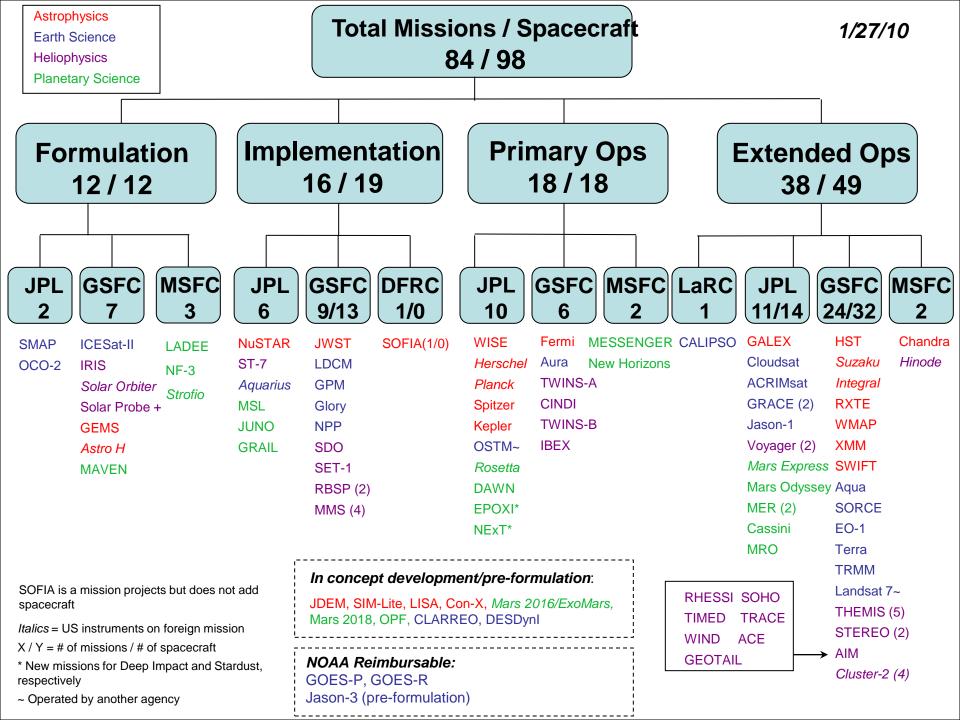
Astrophysics Optics Future

Mr. Michael R. Moore Astrophysics Associate Director for Innovation and Technology June 2010

Astrophysics Tackles Big Questions

- How do planets and life originate?
- What is the origin and destiny of the universe?
- Are we alone?

Big Questions often require big systems to get at the answer With Astrophysics, this usually means big (expensive) Optics We have built and are building some of the finest systems ever





Astrophysics

Questions

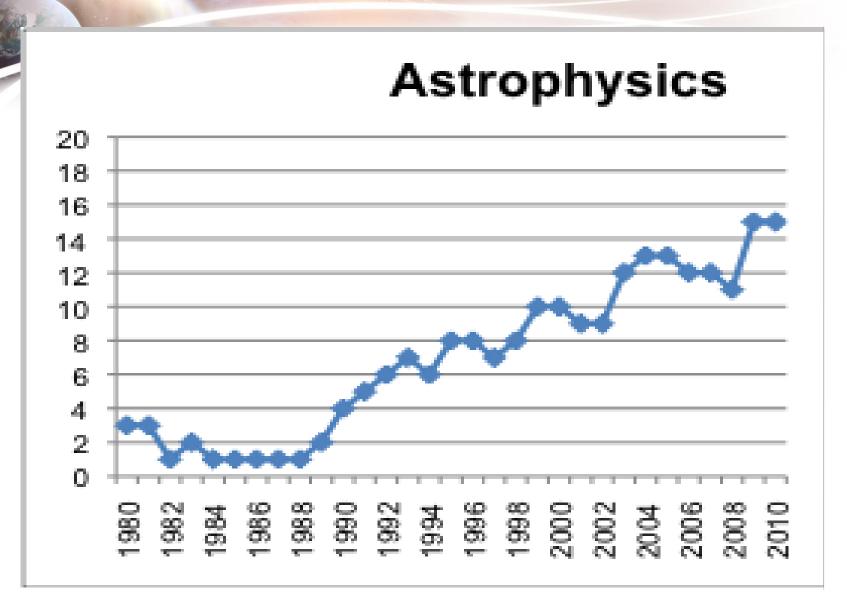
How do matter, energy, space and time behave under the extraordinary diverse conditions of the cosmos?

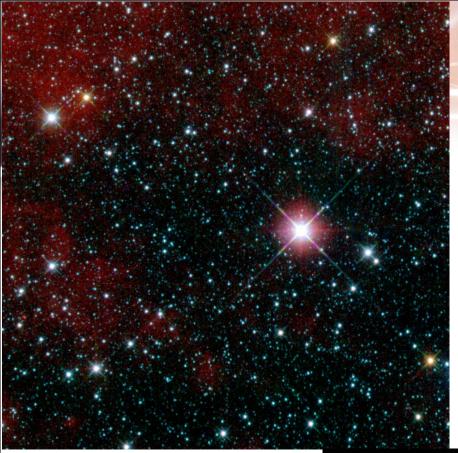
How did the universe originate and evolve to produce the galaxies, stars, and planets we see today?

What are the characteristics of planetary systems orbiting other stars, and do they harbor life?



Number of Operating Astrophysics Missions Over Time

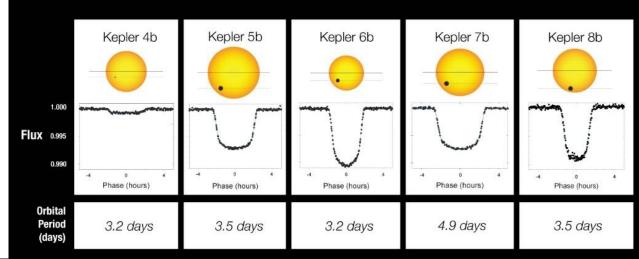




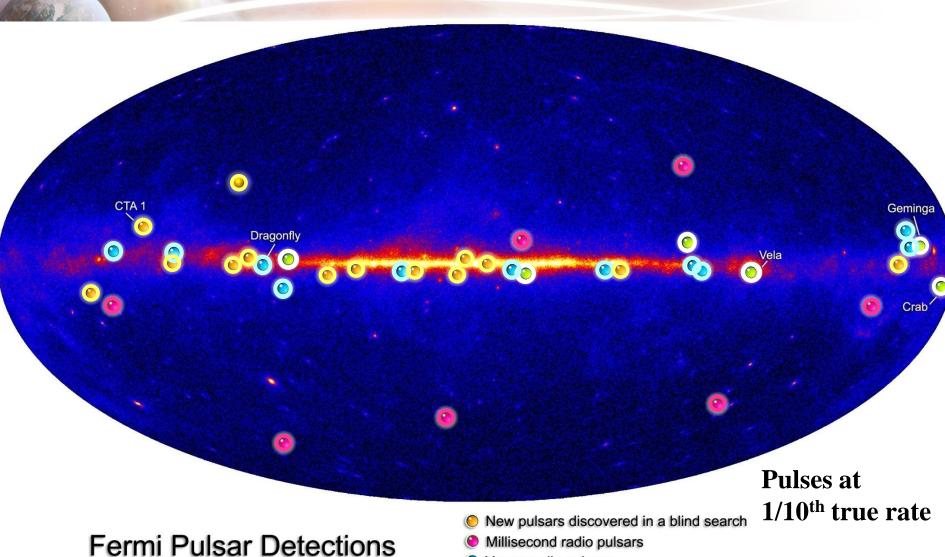
Early Science Results from Kepler and WISE

 NASA's Kepler space telescope, designed to find Earth-size planets in the habitable zone of sun-like stars, has discovered its first five new exoplanets, or planets beyond our solar system.

 NASA's Wide-field Infrared Survey Explorer, or WISE, has captured its first look at the starry sky that it will soon begin surveying in infrared light.

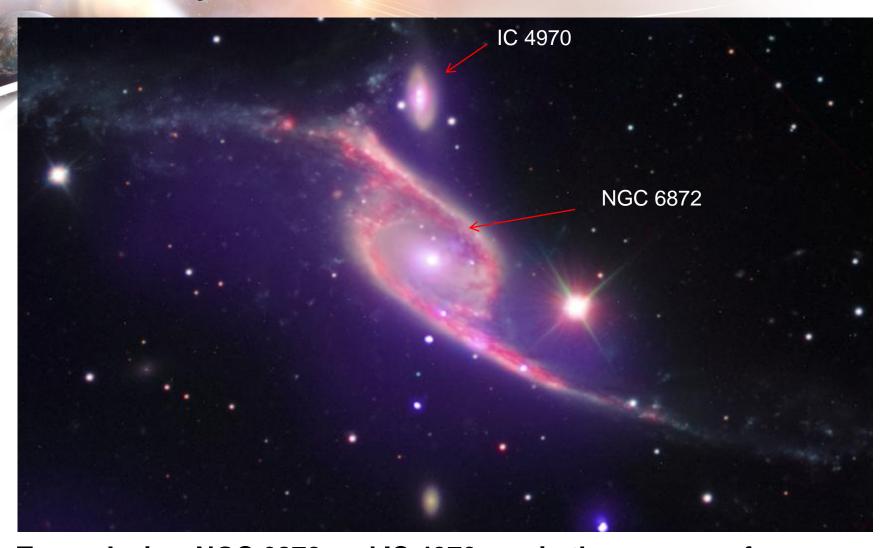


Fermi: New Populations of Pulsars!



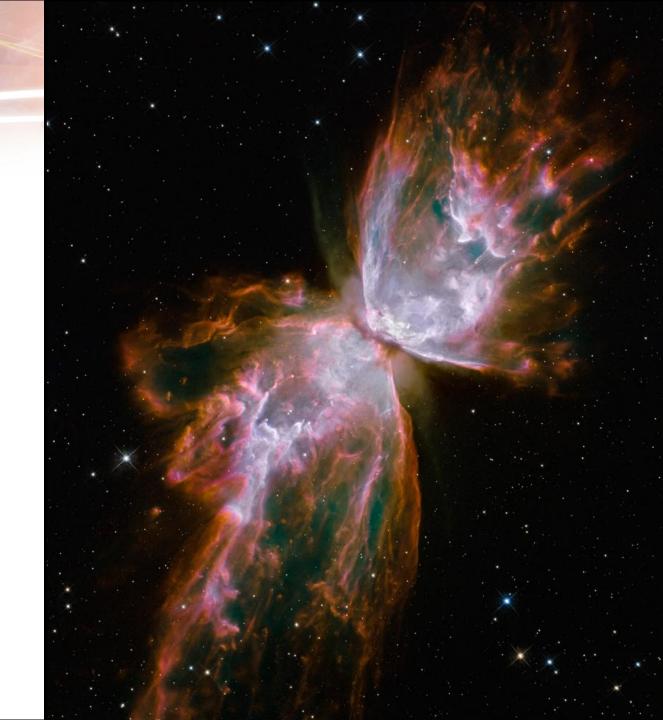
- Young radio pulsars
- O Pulsars seen by Compton Observatory EGRET instrument

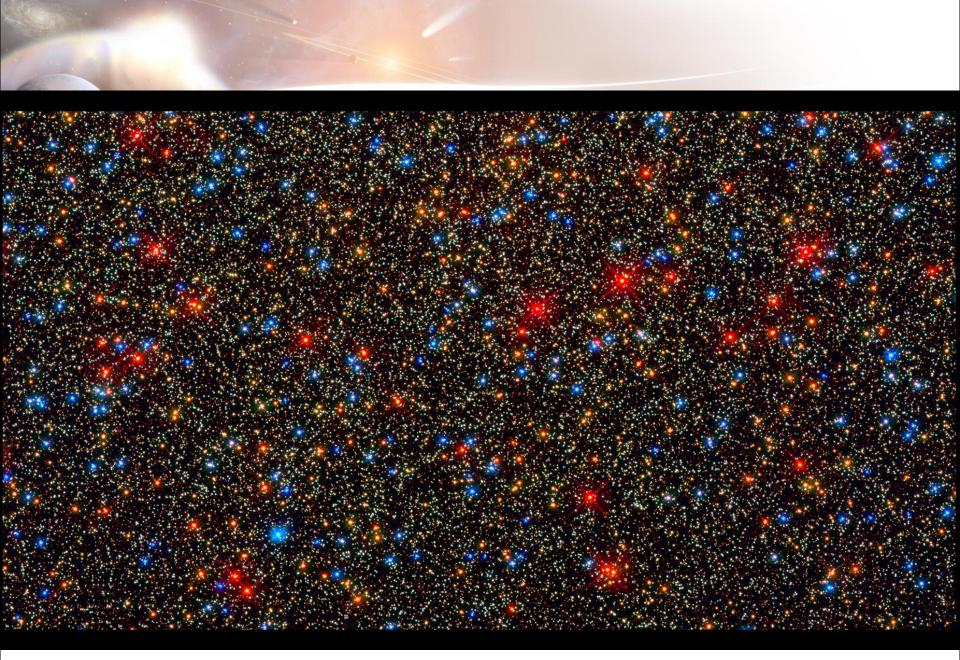
Galaxy Collision Switches on Black Hole



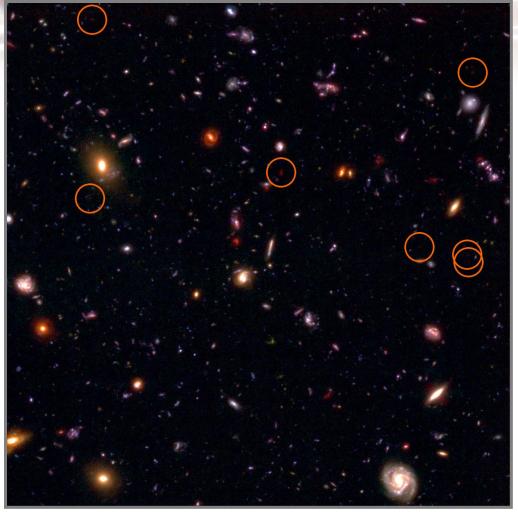
Two galaxies, NGC 6872 and IC 4970, are in the process of merging. Based on Chandra and Spitzer data it is known that the small galaxy IC 4970 contains an active super-massive black hole.







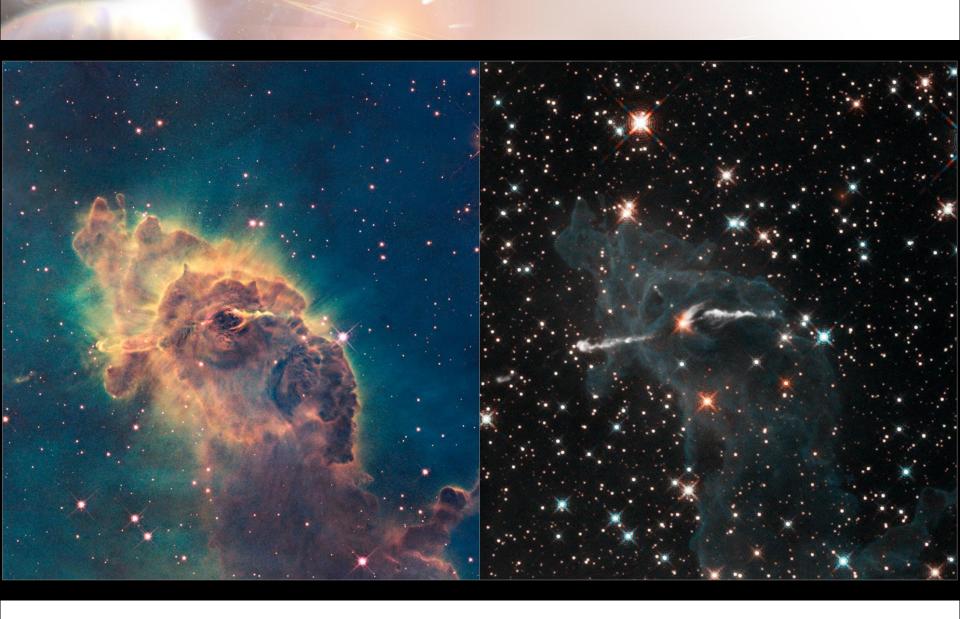
Hubble's Deepest View of the Universe



 The Hubble Space Telescope has acquired the deepest image of the universe ever taken in near-infrared light using the newly installed Wide Field Camera 3.

2009 Infrared Ultra Deep Field

Gravitational Lensing



Where Next?

We are driving to get our flagships out the door and operating JWST is getting into serious integration activities SOFIA is starting initial Science Flights this Fall

We are working to get our new Explorers done on cost and schedule NuSTAR is in integration GEMS is waiting in the wings for a start

We are working with ESA on the decisions they are making on Cosmic Visions Medium and Large Missions

We are waiting on our Decadal Survey results to help guide our next Mission selections

NASA FY11 Budget Overview

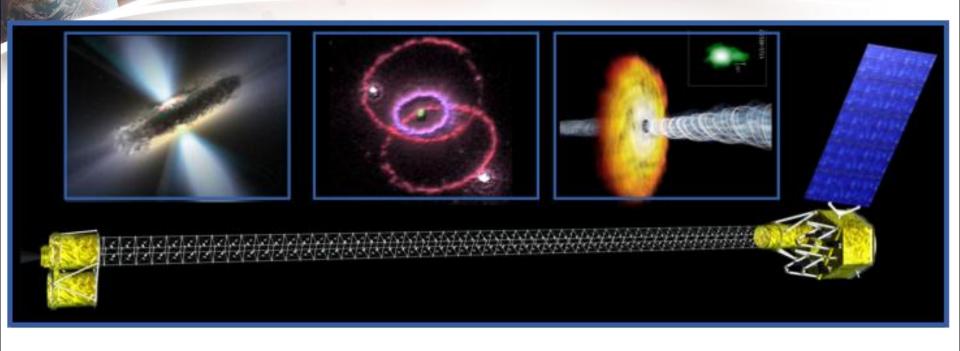
	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	Change FY10-15	
Science	<u>\$4,903.1</u>	\$4,493.3	\$5,005.7	\$5,248.7	\$5,509.7	<u>\$5,709.9</u>	<u>\$5,814.1</u>	\$1,320.8	29%
Earth Science	\$1,702.3	\$1,420.7	\$1,801.7	\$1,944.5	\$2,089.5	\$2,216.6	\$2,282.2	\$861.5	61 %
Planetary Science	\$1,288.1	\$1,341.3	\$1,485.8	\$1,547.3	\$1,591.3	\$1,630.2	\$1,649.5	\$308.2	23%
Astrophysics	\$1,304.9	\$1,103.9	\$1,076.3	\$1,109.3	\$1,149.1	\$1,158.7	\$1,131.6	\$27.7	3%
Heliophysics *	\$607.8	\$627.4	\$641.9	\$647.6	\$679.8	\$704.4	\$750.8	\$123.4	20%

^{*} includes future Astro Explorers

FY2011 Budget Request: Astrophysics

- Fully funds JWST for launch in summer 2014.
- Operates Hubble and other missions.
- Fully funds NuSTAR and ASTRO-H (with JAXA) for launches in 2012 and 2014 respectively.
- Continues support of GEMS explorer mission for launch in 2014.

NuSTAR - Nuclear Spectroscopic Telescope Array (2012)



- Conduct a census for black holes on all scales using wide-field surveys of extragalactic fields and the Galactic center.
- Map radioactive material in young supernova remnants for studying the birth of the elements and to understand how stars explode.
- Observe relativistic jets found in the most extreme active galaxies and to understand what powers giant cosmic accelerators.

Stratospheric Observatory For Infrared Astronomy (SOFIA – Fall 2010)



James Webb Space Telescope (2014) Searching for the First Light of the Early Universe



NRC Decadal Surveys Status

Earth Science – First survey published in Jan. 2007

Astrophysics – Last survey in 2001; next survey expected in Sept. 2010

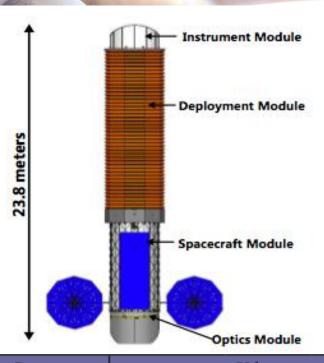
Planetary Science – Last survey in 2002; next survey expected in Spring 2011

Heliophysics – Last survey in 2003; next survey under discussion for early 2012

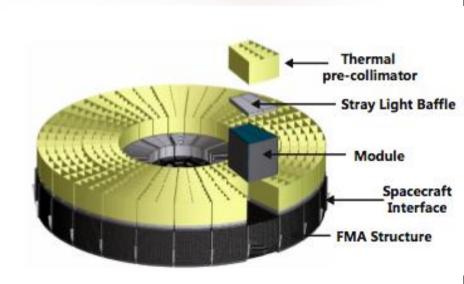
Potential New Missions

IXO JDEM SIM-LITE LISA

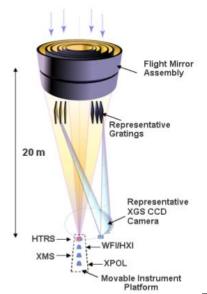








	- 0	tics Module		-	
Parameter		Value		Science Driver	Inst.
Mirror Effective Area	3 m ² @ 1.25 0.65 m ² @ 6 keV 150 cm ² @ 30 ke	7		Black Hole Evolution Strong Gravity Strong Gravity	
Spectral Resolution (FWHM), FOV, bandpass	$\Delta E = 2.5 \text{ eV}$ $\Delta E = 10 \text{ eV}$ $\Delta E = 150 \text{ eV}$ $E/\Delta E = 3000$	2 arcmin 5 arcmin 18 arcmin point src	0.1-15 keV	Galaxy Cluster Evolution Cosmic Feedback Black Hole Evolution Cosmic Web	XMS XMS WFI/HXI XGS
Angular Resolution	5 arcsec HPD 5 arcsec HPD 30 arcsec HPD	0.3–7 keV 0.1–7 keV 7–40 keV		Cosmic Feedback Black Hole Evolution Strong Gravity	XMS WFI/HXI WFI/HXI
Count Rate	106 cps with <10	% deadtime		Neutron Star Eq. of State	HTRS
Polarimetry	1% MDP, 100 ks	sec,5 × 10 ⁻¹² o	cgs (2-6 keV)	Strong Gravity	XPOL



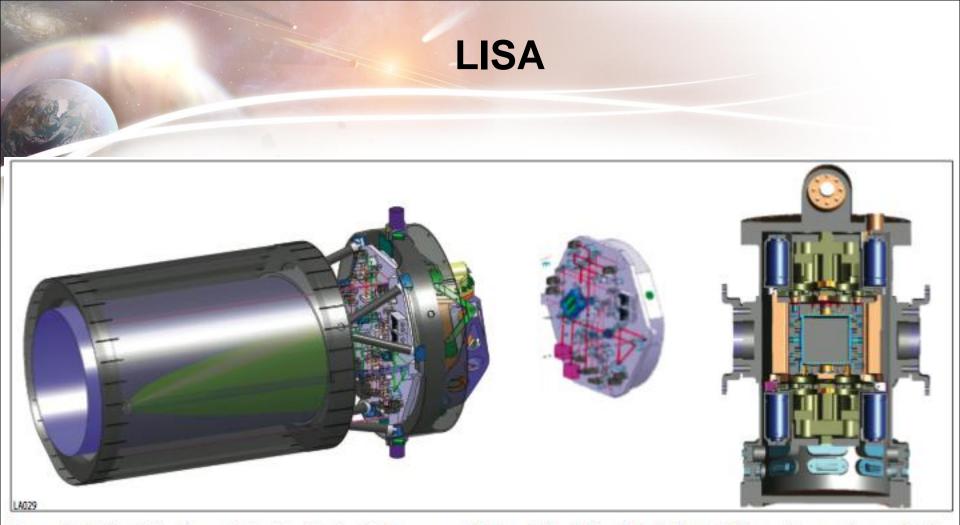
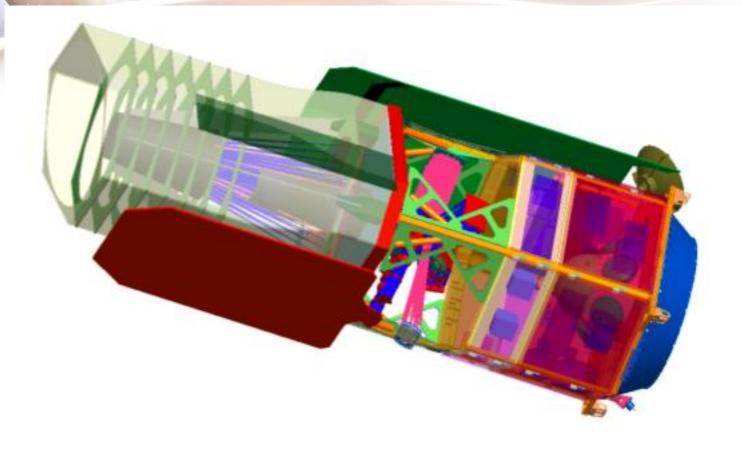


Figure 2—2: The Optical Assembly (left) with off-axis telescope, optical bench (center) and Gravitational Reference Sensor cutaway (right).

40 cm Off-axis telescopes (6 total)

JDEM/IDECS, ALPHA and OMEGA



Option/Parameters	JDEM/IDECS			AL	PHA	OMEGA		
Aperture (m)		1.5		1.2		1.5		
Channel Types	VISI	NIRI	NIRS (2)	VISI	NIRI	NIRI	NIRS	

SIM Lite Astrometric Observatory

Salient Features

- 6 meter science Michelson Stellar Interferometer (MSI) with 50 cm siderostats
- One 4m MSI and one 30cm T-scope Guides
- Visible wavelength
- KSC launch on medium-class ELV
- Earth-trailing solar orbit, 5 year mission
- SIM is a JPL, Caltech, NGAS, KSC, and SIM Science Team partnership

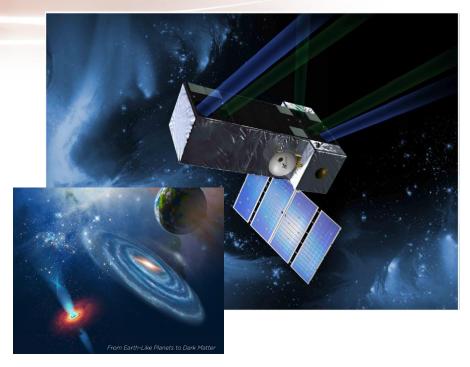
Science

- Finding Earths (searches habitable-zones of 60-100 nearby sun-like stars)
- Dark Matter & Galaxy Assembly
- Precision Stellar Astrophysics
- Supermassive Black Hole Astrophysics

Brief History

 Investment over past 14 yrs, ~\$600M, has evolved design to minimum configuration able to meet prior NRC Decadal and AAAC Exoplanet Task Force recommendations.

Currently under review by the NRC Astro2010 Decadal Survey



Technical Status

- Technology development completed in 2005.
- Developed/developing flight form-fitfunction hardware for all critical instrument subassemblies.
 - Flight environmentally tested.

For further details

• See the SIM Lite book available from the project website:http://sim.jpl.nasa.gov26

Comments for this Community

Our resources for the future look limited

The results of the decadal are crucial

Potential missions in this Decade seem feasible with existing mirror technology

Potential future mission starts in the 20's might be a good target for technology investments based on a spread of concepts

Key elements in large optics remaining to be solved include:

Cooling, control, production rate, and as always, cost!